REMARKS/ARGUMENTS

The Office Action (1) objected to claims 6, 15 and 17 because of informalities; (2) rejected claims 23-25 under 35 U.S.C. 102(e) as being anticipated by Li (USPN 6,613,656); (3) rejected claims 1-4, 8-13, 16-18,27-28, and 31-35 under 35 U.S.C. 103(a) as being unpatentable over Li; (4) rejected claims 5-7 under 35 U.S.C. 103(a) as being unpatentable over Li as applied above, in view of Soininen et al. (US 2002/0004293); (5) rejected claims 14 and 29 under 35 U.S.C. 103(a) as being unpatentable over Li as applied to claim 1 above, in view of Pinneo (USPN 5,902,563); (6) rejected claims 15, 20 and 30 under 35 U.S.C. 103(a) as being unpatentable over Li in view of Pinneo, as applied to claim 14 above, and further in view of Flamm et al. (USPN 4,918,031); (7) rejected claim 26 under 35 U.S.C. 103(a) as being unpatentable over Pinneo; (8) rejected claims 1-4, 7-13, 16-17, and 20 under the judicially created doctrine of obviousness-type double patenting.

(1) Regarding the objection to claims 6, 15 and 17 because of informalities, Applicants have canceled claim 6 and modified claims 15 and 17 to speed up prosecution. Applicants may chose to file the canceled claims at a later time.

(2) Regarding the rejection of claims 23-25 under 35 U.S.C. 102(e) as being anticipated by Li, Applicants have canceled these claims to speed up prosecution. Applicants may chose to file the canceled claims at a later time.

(3) Regarding the rejection of claims 1-4, 8-13, 16-18, 27-28, and 31-35 under 35 U.S.C. 103(a) as being unpatentable over Li, Applicants submit that the present application is distinct from Li due to a separate and sequential plasma treatment step.

Under certain deposition conditions, the deposited film (e.g. TiN film) can contain some impurity, for example, Cl_2 in $TiCl_4/NH_3$ process, or C in TDMAT process. Thus the present application provides a separate and sequential plasma treatment (step b) to treat the already deposited film (e.g. TiN) in a previous step (step a), for example, to remove the impurity (e.g. Cl_2 or C).

Applicants submit that Li is silent with respect to the plasma treatment. Li discloses a reactor chamber capable of plasma generation, but Applicants submit that Li does not teach nor disclose any plasma treatment process so that persons with ordinary skills in the art can anticipate a plasma treatment process to modify the deposited film.

The Examiner stated that the second reactant of Li can be introduced using a plasma, and this plasma can simultaneously perform a plasma treatment of the deposit film. Applicants submit that the scenario proposed by the Examiner is not a plasma treatment of the deposited film, but a plasma excitation of the depositing reactant, employed during deposition. The simultaneous plasma exposure of Li's plasma, if used, is for deposition process itself, and not a treatment of the already deposited film.

The plasma treatment of the present invention is a distinct, separate, and sequential plasma treatment, which is independent of the deposition process. There are unexpected benefits for the present invention separate and sequential plasma treatment, which are:

(a) an additional control over the deposited film quality (plasma treatment can be performed after a plasma deposition);

(b) the reactant for plasma treatment can be different from the deposit reactant (for example, in $TiCl_4/NH_3$ process, Li's process requires NH_3, while the present invention can employ N_2 for nitrogen-rich TiN, H_2 for Ti-rich TiN, O_2 for TiON);

(c) non-interference with the deposition process (the treatment is independent of the deposition); and

(d) permitting the plasma treatment following a deposition by decomposition (deposition by decomposition requires only one precursor which decomposed in the wafer surface, thus there is no reactant in Li's process).

Thus, Applicants submit that the present invention discloses a plasma treatment process to treat the already deposited film, which is not mentioned nor anticipated in Li's disclosure.

The novelty of Li is the separation of the deposition's set of reactant into two components: a precursor gas and a reactant gas, which are then sequentially injected into a reaction chamber. This is in contrast to conventional CVD where the precursor and the reactant gas are injected together:

The novel fabrication method of the present invention sequentially injects a precursor and a reactant into a reaction chamber. In a conventional CVD fabrication technique, the precursor and the reactant are overlappingly injected into a reaction chamber... Li, Col. 8, lines 44-49.

The precursor gas first saturate the volume near the substrate surface:

Precursor gas to saturate near substrate surface (Fig. 3, step 214).

Then the reactant gas flows in to react with the precursor gas:

Reactant gas to react with precursor near substrate surface (Fig. 3, step 222).

The reaction of these two components deposits the desired layer:

The precursor gas and the reactant gas chemically react and deposit the desired material in a layer on the substrate. Col. 6, lines 53-55.

The reactant gas flows into the chamber until a sufficient quantity of reactant gas is available to react with the precursor at the surface of the substrate to deposit the desired film. Col. 7, lines 48-51.

Moreover, SPD requires that the precursor remains in the chamber until the chemical reaction with the reactant gas occurs and the film is deposited on the substrate. Col. 7, lines 60-63.

In an alternative embodiment, Li discloses that the sequence can be reverse, that the reactant can be injected first. However, the precursor and the reactant are still needed for the deposition reaction:

The precursor will enter the volume and react with the already present reactant gas and form a film on the substrate. Col. 8, lines 38-40.

A deposition process of TiN using $TiCl_4$ and NH_3 can serve as an example:

$$TiCl_4 + NH_3 \rightarrow TiN + \text{by-products}$$

Li's process would be flowing $TiCl_4$ first into the reaction chamber to saturate the volume of the substrate surface, then NH_3 flows into the reaction chamber to react with $TiCl_4$, forming TiN.

In contrast, step a of the process of the present application would be flowing a first reactant of $TiCl_4$ and NH_3 to the reaction chamber to form TiN.

Further, Applicants submit that Li cannot anticipate an exemplary embodiment of the present invention of deposition by decomposition (e.g., depositing a layer of TiN using TDMAT decomposition), and then treating the deposited layer with plasma N_2. The deposition reaction would be a thermal decomposition of TDMAT precursor:

$$TDMAT \rightarrow TiN + \text{by-products}$$

Since the deposition uses only TDMAT, Applicants submit that Li cannot anticipate this deposition reaction. And thus there is no plasma reactant from Li. Also, the present invention can use a variety of reactant for treatment (e.g. N_2 in this particular exemplary embodiment). Specific embodiments of Li's reactant are only reactive gas (which are a part of the deposition reaction) such as oxygen-containing gas.

- Claim 1

Regarding claim 1, Applicants submit that the present application further discloses a deposition process that comprises two sets of reactant: a first set of reactant to deposit a first layer, and a second set of reactant to deposit a second layer. In contrast, Li discloses a process that requires only one set of reactant to deposit a layer without any plasma treatment.

- Claim 18

Regarding claim 18, Applicants submit that the present application further discloses a deposition process that comprises two sets of reactant: a first set of reactant to deposit a first layer, and a second set of reactant to plasma treat the deposited layer. In contrast, Li discloses a process that requires only one set of reactant to deposit a layer without any plasma treatment.

- Claim 27

Regarding claim 27, Applicants submit that the present application further discloses a deposition process that comprises two sets of reactant: a first set of reactant to deposit a first layer, and a second set of reactant to deposit a second layer. In contrast, Li discloses a process that requires only one set of reactant to deposit a layer without any plasma treatment.

In sum, Applicants submit that Li is silent with respect to the plasma treatment and the second set of reactant for the plasma treatment. Li discloses a reactor chamber capable of plasma generation, but Applicants submit that Li does not teach nor disclose any plasma treatment process so that persons with ordinary skills in the art can anticipate a plasma treatment process to modify the deposited film.

Claims 2-4, 8-13, 16-17, 28, and 31-35 are dependent upon an independent claim, and therefore should be allowed per the same reasons as discussed above.

Regarding claim 3, Applicants submit that Li only discloses a reactor capable of plasma deposition, not a sequential and separate plasma treatment, as evidenced in Col. 5, lines 26-34:

One embodiment includes plasma reactors because these allow film deposition at lower temperatures and are used in semiconductor industry. However, some reactant constituents in the process gases may deposit at low temperatures using only thermal energy or other energy source. Hence, the invention encompasses reactor designs using any energy source including either thermal heating, RF plasma, or the like. Underlined provided by Applicants.

(4) Regarding the rejection of claims 5-7 under 35 U.S.C. 103(a) as being unpatentable over Li as applied above, in view of Soininen et al., Applicants submit that these claims are dependent on independent claim 1, thus should be allowed for at least the same reasons as discussed above.

(5) Regarding the rejection of claims 14 and 29 under 35 U.S.C. 103(a) as being unpatentable over Li as applied to claim 1 above, in view of Pinneo, Applicants submit that these claims are dependent on independent claims 1 and 27, thus should be allowed for at least the same reasons as discussed above.

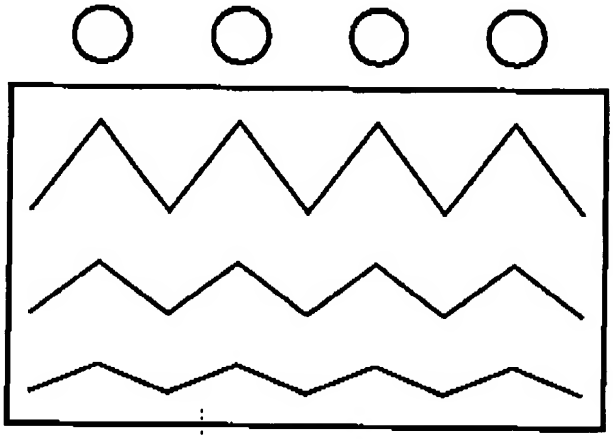
(6) Regarding the rejection of claims 15, 20 and 30 under 35 U.S.C. 103(a) as being unpatentable over Li in view of Pinneo, as applied to claim 14 above, and further in view of Flamm et al., Applicants submit that Flamm et al. does not disclose a helical ribbon electrode for the plasma.

Applicants submit that the use of ribbon to form the helical shape is not obvious to persons with ordinary skills in the art, following Flamm et al.'s teaching, due to the facts that the

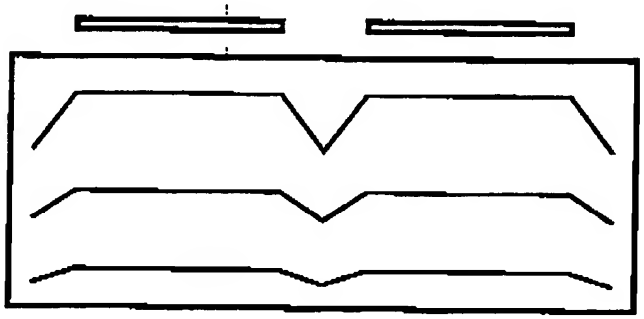
ribbon helical electrode provides better uniformity, smaller reactor chamber volume and higher plasma power.

- Better uniformity: The plasma distribution in the process chamber follows the shape of the electrode, thus round coil as disclosed by Flamm et al. provides sharp peaks and valley. In contrast, a ribbon electrode provides a flat distribution.

- Smaller reactor chamber volume: With flatter distribution, the reactor chamber volume can be smaller and can still achieve a good uniformity.



Plasma distribution for Flamm et al.



Plasma distribution for the present application

- Higher plasma power: Plasma power is proportional to the number of turns, and to the proximity of the electrode to the chamber volume. With ribbon electrode, any turns can be provided with essentially the same distance to the chamber volume due to the extremely thin

Further, regarding claim 20, Applicants submit that the present application discloses a deposition process that comprises a separate plasma treatment, plus two sets of reactant: a first set of reactant to deposit a first layer, and a second set of reactant to deposit a second layer. In contrast, Li discloses a process that requires only one set of reactant to deposit a layer without any plasma treatment.

Thus, similar to the argument for claim 1 above, the disclosure of Li thus differs from the present application by the plasma treatment, plus the usage of two sets of reactant.

(7) Regarding the rejection of claim 26 under 35 U.S.C. 103(a) as being unpatentable over Pinneo, Applicants submit that the helical ribbon element can provide better plasma uniformity, as per discussion above. Applicants submit that persons with ordinary skills in the art cannot employ Pinneo's teaching to adapt the helical element of Pinneo to improve plasma uniformity as much as the helical ribbon element of the present invention.

(8) Regarding the rejection of claims 1-4, 7-13, 16-17, and 20 under the judicially created doctrine of obviousness-type double patenting, Applicants submit a terminal claimer to overcome the Examiner's rejection.

Applicants respectfully request that a timely Notice of Allowance be issued in this case.

The Commissioner is authorized to charge any underpayment or credit any overpayment to Deposit Account No. 06-1325 for any matter in connection with this response, including any fee for extension of time, which may be required.

Respectfully submitted,

Date: 6/20/06

By: _____
Sheldon R. Meyer
Reg. No. 27,660

FLIESLER MEYER LLP
Four Embarcadero Center, Fourth Floor
San Francisco, California 94111-4156
Telephone: (415) 362-3800